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(54) Data recorder

(57) A pocketable data recorder 10, carried in a pocket of a pilot, receives and stores in its memory 13 a copy of at least some of the data stored in the main crash recorder memory 3 of an aircraft "black box" flight data recorder 1. As shown the latter includes a radio transmitter 4 and antenna 5, but the transmission may be via an inductive loop around the aircraft cockpit (Fig. 2 not shown).

The recorder may store only some of the data stored in the main crash recorder 1. Data may be recorded contemporaneously with the recording in the main recorder, or may be transferred as a high-speed burst in response to operation of the pilot's ejector seat. The memory 13 may comprise any type of non-volatile memory. Where data is transferred in a burst, data may be initially stored in a high speed volatile memory provided in the recorder and thence copied into the non- volatile memory.

Data may be continually over-written by fresh data. At least some data, e.g. speech, may be stored permanently.

If the aircraft crashes in inaccessible terrain, or in deep water, the data carried by the pilot's recorder may provide sufficient information about the cause of the crash to obviate the need to recover the main crash recorder.

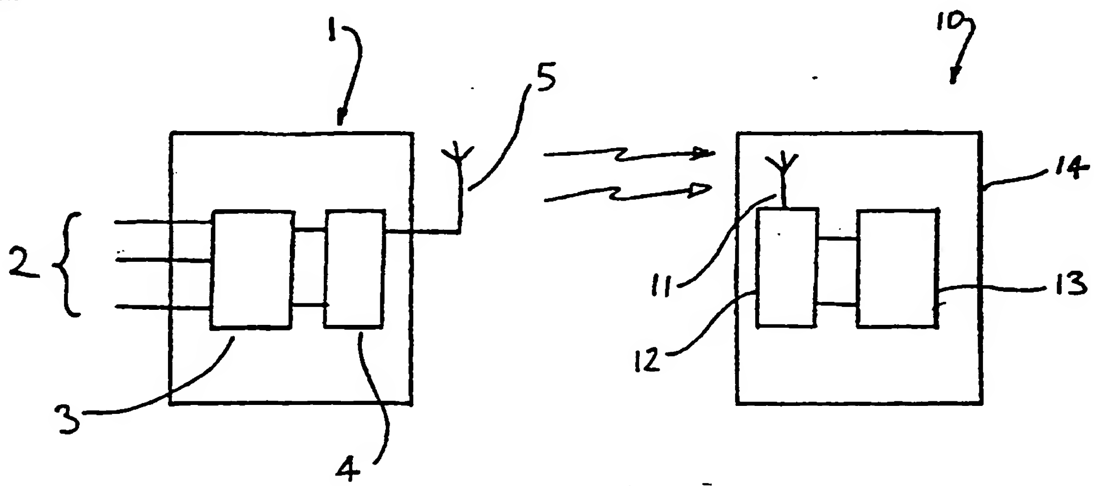

Fig 1

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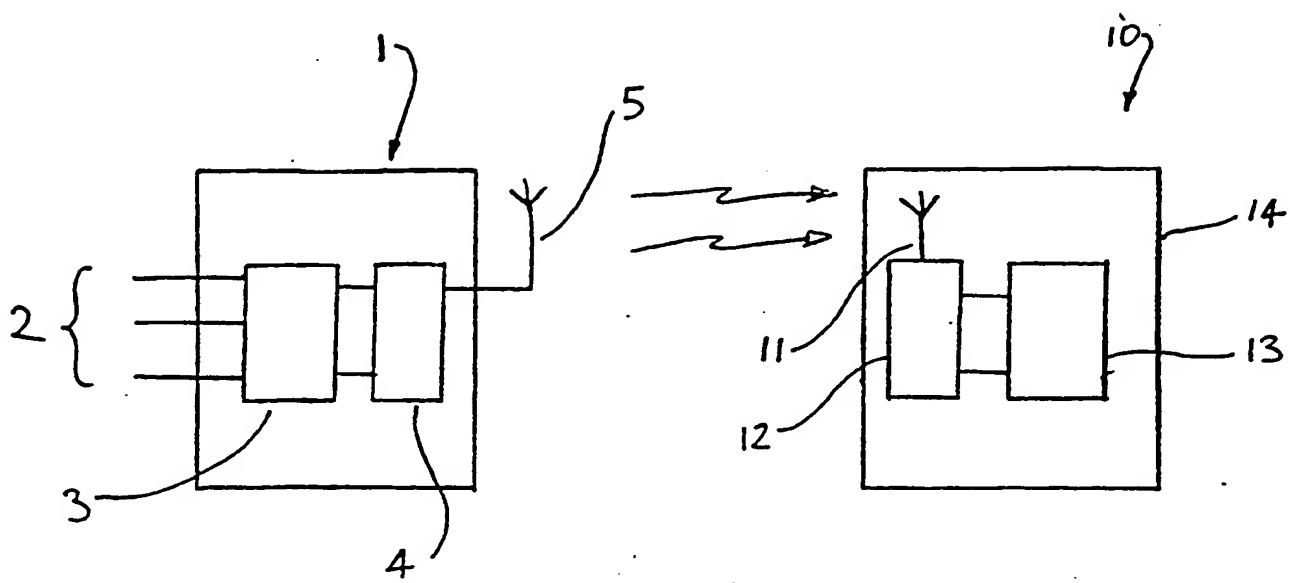

Fig 1

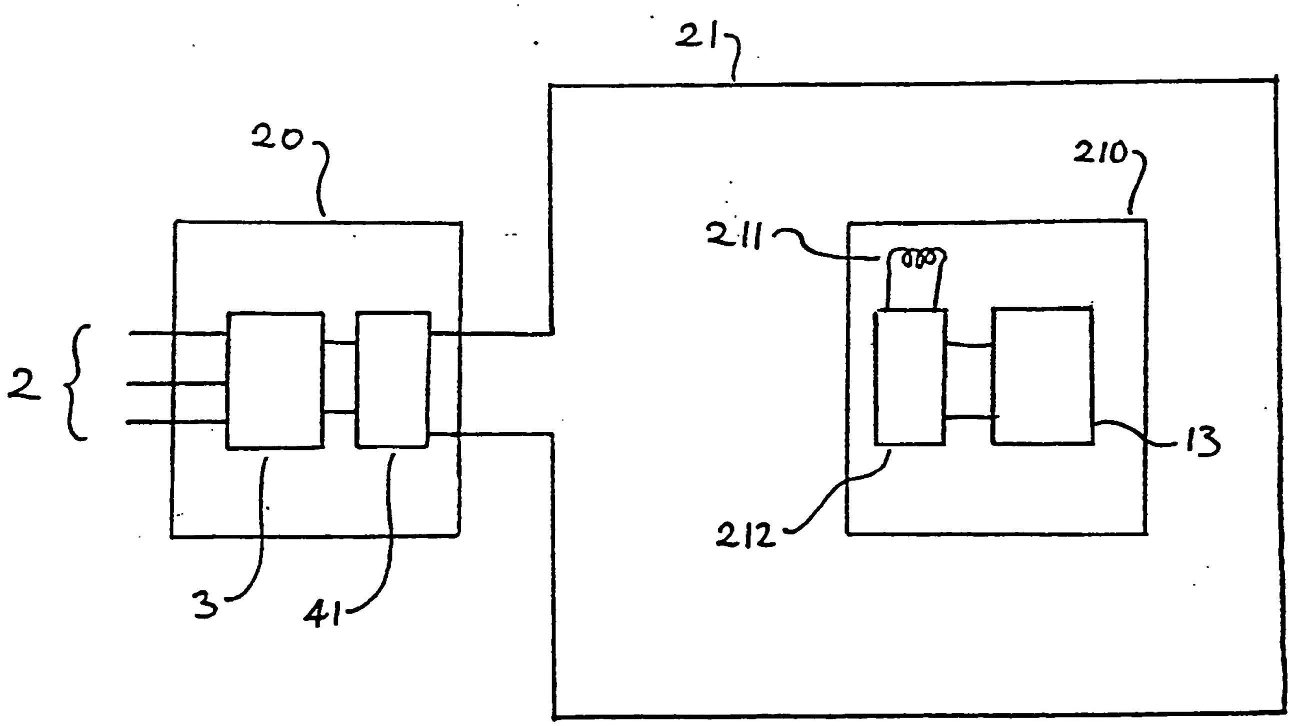

Fig 2

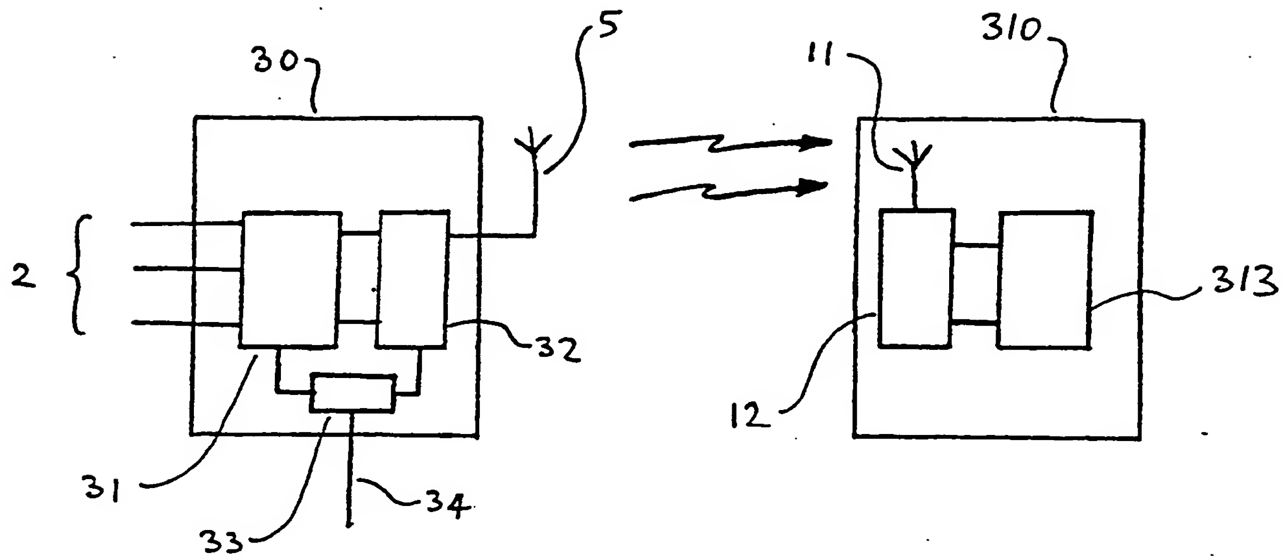

Fig 3

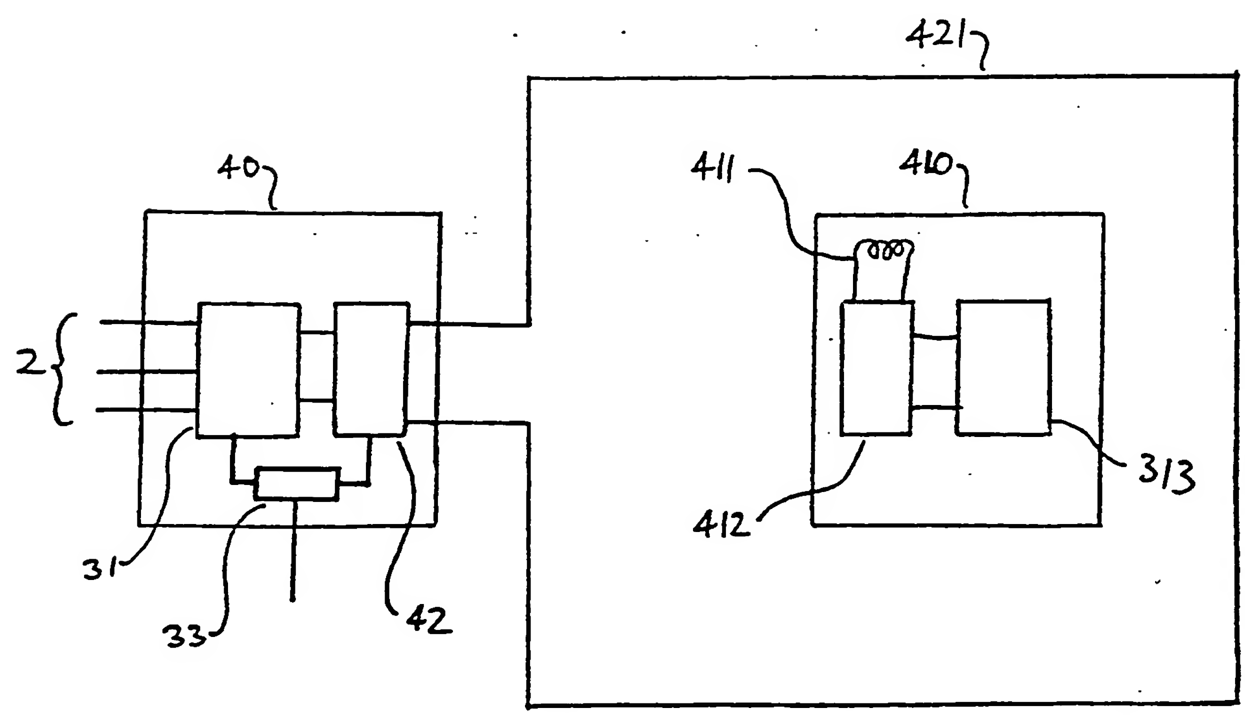

Fig 4

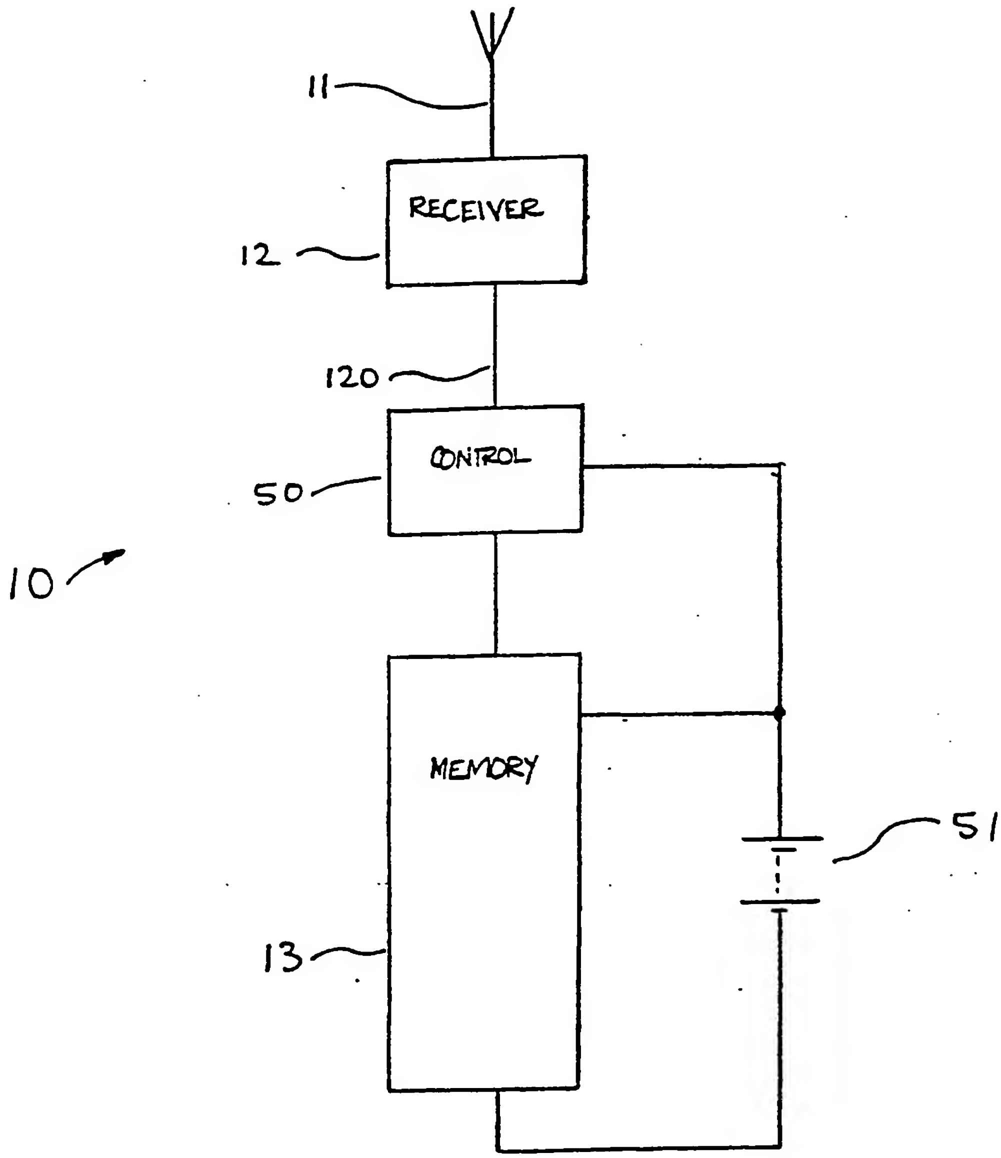

Fig 5

DATA RECORDER

This invention relates to data recorders. Data recorders have found application in a number of fields, for example, the Crash Survival Memory Units (CSMU) or Flight Data Recorders (FDR), popularly referred to as "Black Boxes", fitted to aircraft. Such data recorders are used to record flight parameters indicating the aircraft instrument readings, control surface positions and system status, as well as cockpit voice recordings. Such data recorders have to be constructed so as to allow the stored data to be retrieved in the event of a crash. As a consequence they are generally relatively bulky and heavy. Such recorders are often positioned in the aircraft tail, and may include auxiliary batteries and a radio transmitter to assist in their recovery after a crash.

Because of their construction and the need for qualification approval in respect of shock, damage, fire resistance, water immersion, etc, such recorders are expensive.

Such recorders continually write data over previously-recorded data, so that only (say) the last 30 minutes of data is kept. On the occurrence of a crash or other stimulus, recording is halted, thereby storing a record of data indicative of conditions in the time window immediately prior to the crash/stimulus. The earlier generations of endless loop wire and magnetic tape based recorders have been superseded by recorders utilising solid-state memory integrated circuits as the

storage medium, typically EEPROM, FLASH EEPROM, static or dynamic RAM.

While such recorders have in general been found satisfactory, difficulties have been encountered with crashes at sea. Apart from the difficulty of locating a sunken aircraft, there is the problem of raising it once you have found it. This can be an intractable problem in very deep water.

It has been proposed to incorporate the crash recorder in the pilot's ejector seat. However, this presents a number of difficulties, especially given the bulk and weight of current crash recorders. Reduction of size and weight to allow fitting to an ejector seat may be incompatible with the requirements of recording duration and withstanding impact and fire damage. In any case the ejection seat will sink in water, making recovery difficult. In addition, any modification, however small, to a standard ejection seat necessitates a prohibitively expensive re-approval procedure.

The present invention seeks to provide an improved data recorder.

In accordance with the invention, a data recording system comprises a transmitter module for receiving data to be stored, the transmitter module comprising means to selectively transmit at least some of the data received thereby; and a pocketable data recorder for receiving data broadcast by the transmitter unit , and comprising data storage means for storing data received from the transmitter

Such a data recorder is small enough and light enough to be carried in the pocket of clothing worn by a person, such as the pilot and/or navigator of an aircraft.

The transmitter module may be arranged to broadcast data continuously. The recorder may be arranged to continuously store the data broadcast by the transmitter in a rolling update manner such that older samples of data are continually over-written by later samples of data. Thus the pocketable data recorder always contains the most recent data.

The recorder is preferably provided as an addition to a conventional "black box" crash recorder incorporated into the aircraft. The pocketable crash recorder may store at least some of the data stored in the conventional crash recorder. The pocketable recorder may be arranged to store such data only on the occurrence of a fault condition, the contents of the main record memory being rapidly read out and copied into the memory of the pocketable recorder. The data recorder ne d not need to be able to withstand the full range of conditions stipulated for a conventional crash recorder, such as fire resistance and shock, but in principle only has to withstand those conditions which must be withstood by the pilot. As a consequence, it can be both physically small and light, and may for example be housed in a waterproof plastics case. Data is preferably stored in a solid-state memory.

If the pilot has to eject for any reason, the data stored in the data recorder

which he has on his person may provide all the information required and may avoid the need to mount an expensive recovery search for the aircraft-mounted data recorder.

The invention will now be described by way of non-limiting example only with reference to drawings in which

Figure 1 shows a first embodiment of the invention;

Figure 2 shows a second embodiment of the invention;

Figure 3 shows a third embodiment of the invention;

Figure 4 shows a fourth embodiment of the invention; and

Figure 5 shows a fifth embodiment of the invention.

The apparatus schematically illustrated in Figure 1 consists of two discr te units. The first unit comprises a data collection and transmission module 1, the second unit comprises a data recorder 10. The data collection and transmission module 1 is provided in the body of an aircraft, not shown. The data recorder 10 comprises a compact, lightweight, pocketable case 14 containing all the operational parts of the recorder. The case 14 is dimensioned such that it can be readily slipped into a pocket of the pilot's clothing. The case 14 has no external wires or other mechanical connections which might otherwise inconvenience the pilot.

Data indicative of various parameters of an aircraft's apparatus is fed, on input lines 2, to a first data recorder 3, which repetitively samples the input data

and stores the samples. In the present embodiment, data recorder 2 comprises a conventional crash recorder which only stores, say, the last 30 minutes worth of data, older data being continually over-written by later data. Data samples are also fed to transmitter 4 which generates a relatively low-power radio frequency signal which is applied to antenna 8. Data recorder 10 is provided with a receiving antenna 11 for receiving the transmitted signals. Antenna 11 is coupled to a receiver 12, which demodulates the signal received from the transmitter. The demodulated signal consists of data identical with the data stored in the crash recorder 2, and this data is stored in a non-volatile memory 13. As with the main crash recorder 2, the non volatile memory 13 only has a limited capacity, and the earliest data is continuously overwritten by the latest data. The recorder 10 operates such that old data is only over-written by new data when new data is received. Thus whenever transmission of data stops for any reason, the data stored in memory 13 remains frozen. Thus, if the pilot has to bail out, he carries with him a record of the condition of his aircraft in the period immediately preceding his exit.

Memory 13 comprises an EEPROM. Because conventional crash recorders sample data at a relatively low rate, and the memory 13 is updated in real time in step with the conventional crash recorder, the relatively long write/erase cycle time of a conventional EEPROM is of no importance.

In figure 2, data to be recorded is supplied to a transmitter 41 which is coupled to an inductive loop 21 disposed about the cockpit of the aircraft. Data

recorder 210 is responsive to the magnetic field generated by the loop 21 and has a receiving coil 211 coupled to a receiver 212. Demodulated data is conveyed to memory 13. Operation is substantially identical with the Figure 1 embodiment, the only difference of substance being the use of an inductive loop, rather than a radio link, to convey data to the recorder carried by the pilot.

In Figure 3, the aircraft-mounted crash recorder 30 comprises a semiconductor non-volatile memory 31, whose contents can be read out rapidly to transmitter 32. Such read-out is instigated by control circuit 33 in response to a suitable command on line 34. In the present embodiment this command is generated when the pilot's ejector seat is operated.

The data recorder 318 has a radio receiver 12, coupled to a memory 313 which is capable of being written to at a high rate. Memory 313 comprises two portions. The first portion comprises a high-speed volatile memory for storing the data as it is received. The second portion comprises a non-volatile memory arranged to store the contents of the volatile memory. Data is written to the portable data recorder only on the occurrence of a hazardous situation. Operation is as follows. Under normal operating conditions, data appearing on input lines 2 is continually stored in memory 31 on a rolling update basis. Transmitter 32 is deactivated. Receiver 12 is in a standby state, only becoming activated on receipt of a suitably coded signal from transmitter 32. Memory 313 is likewise deactivated.

Say now that a hazardous situation arises and the pilot has to operate his ejector seat. The signal on line 34 now activates transmitter 32, and causes memory 31 to download its contents to transmitter 32 transmission of data by transmitter 32 is preceded by a coded burst which instructs the data recorder 310 to prepare itself to receive data. Receiver 12 of data recorder 310 senses the commencement of transmissions, and powers-up memory 313. As data is received, so it is stored in memory 313. Data transfer takes place at an extremely high rate such that the entire contents of memory 31 become copied into the memory 313 before the pilot is out of range of the transmitter 32.

Once all the data has been copied into the volatile memory, the contents of the volatile memory are read out and copied into the non-volatile memory. Because, in general, non-volatile memories are slower than volatile, this read-out and copying takes place more slowly than the rate at which data was read into the volatile memory. Such transfer can take place after the pilot is out of range of the transmitter.

The volatile/non volatile memory combination may comprise any suitable arrangement known to those skilled in the art. For example, it may comprise two discrete memory devices and associated control circuitry. Alternatively, it may comprise a unitary memory device of known type in which a non-volatile memory is provided in association with a volatile memory such that data can be transferred from volatile to non-volatile memory on receipt of a suitable command signal.

The arrangement of Figure 4 differs from Figure 3, only in that data is conveyed via an inductive loop in the manner of Figure 2 . Data to be transmitted is applied to loop driver 42 coupled to inductive loop 421. Signals generated in receiver core 411 are supplied to receiver 412, and demodulated data is supplied to memory 313. Operation is otherwise identical with the Figure 3 embodiment.

One example of a suitable recorder 10 is shown in greater detail in Figure 5. Receiver 12 comprises a simple crystal set-type arrangement in which a rectifier is used to detect and demodulate the incoming radio frequency signal. The detected signal supplied via line 120 to control circuit 50, will, on receipt of a suitably coded signal, cause the demodulated incoming data to be conveyed to memory 13. Control circuit 50 and memory 13 are powered by battery 51.

The above embodiments are given by way of example only, and a number of modifications are possible within the scope of the invention. In the cases where data is not down-loaded continuously, down-loading need not be initiated in response to the operation of the pilot ejector seat, but that can be initiated by any other convenient means, for example covering the depressurisation or even manually at the instigation of the pilot.

The data recorder need not be restricted to recording data indicative of instrument readings but may include speech. A 1 Mbit memory can store about 20 seconds of speech when band limited to 3 kHz, and greater capacity may be obtained by the employment of speech compressing techniques. Thus a "memo"

speech storage facility may be provided.

The data recorder need not duplicate all the data stored in the main memory. For example, it may store only those data channels which are considered to be the most significant. Alternatively it may record all the data channels, but may skip samples of data, recording say, every other sample. This would double the effective recording time at the expense of resolution. Alternatively both techniques could be used, only some of the data channels being stored at a reduced sampling rate as compared with the main data recorder. Further, the main data recorder may be dispensed with, the pilot-carried data recorder being the only means of recording data. In this case data will be fed directly to the transmitter 4 or 41.

Further, at least some of the data may be permanently stored rather than being continually over-written. For example, speech messages stored using the memo facility may be stored permanently, whereas instrument reading data is continually over-written. Data relating to one or more instrument readings may be permanently stored while other instrument readings are continually over-written. In such arrangements the memory capacity must be sufficient to permanently store the relevant data concerning the longest expected flight.

Further, where the data recorder memory comprises a volatile portion and a non-volatile portion, data may be continually read into the non-volatile portion in a rolling-update manner, data only being transferred into the non-volatile portion

when the ejector seat is operated.

The invention is not restricted to use in aircraft but may be employed in any field where there is a requirement to store data on the body of a person. A worker in a hazardous environment could carry a record of the environmental conditions to which he has been subjected, or the driver of a vehicle could carry a record of the vehicle performance and/or the driver's physiological state.

To provide added security, a further data recorder may be provided, the further recorder being functionally equivalent to the recorder carried by the pilot, but arranged in a buoyant housing. The further data recorder may be arranged to be ejected from the aircraft substantially simultaneously with the pilot, or may be ejected in response to a command by the pilot. As the further data recorder is released before the aircraft crashes, it does not have to withstand the high forces associated with a crash, nor the high temperatures associated with a fire. It can therefore be of relatively light-weight construction.

Although the invention has been described as employing radio or inductive loop coupling paths between transmitter and recorder, any other suitable means of conveying information in a contactless manner may be employed, for example, optical or sonar communication links.

The information may be down-loaded from the recorder by any convenient means. When used as a flight data recorder, data will in general only need to be

down-loaded on the rare occasions where an incident has occurred in flight necessitating the pilot leaving his aircraft. Thus, when the recorder utilises an EEPROM, it may be convenient to provide the recorder with a socket into which the EEPROM is plugged. Data may then be recovered by opening the casing of the recorder, removing the EEPROM from its socket, and inserting it into a suitable reader unit. In cases where data needs to be routinely recovered, a suitable plug and socket connector may be provided on the recorder housing. Alternatively any contactless data communication link may be employed.

It is known that certain types of EEPROM only have a limited number of read/write cycles. Such memories are suited for applications in which data is only down loaded into non-volatile memory on the occurrence of a fault. Alternatively, if the maximum number of read/write cycles will not be exceeded during the longest possible flight, than an EEPROM can be used in a rolling-update mode, a new EEPROM being used for each flight.

As an alternative to an EEPROM, a conventional low-power static memory may be employed in conjunction with a battery.

The invention is not restricted to EEPROMS or semiconductor memories, and any convenient means of storing data in a non-volatile manner may be employed.

CLAIMS

1. A data recording system comprising a transmitter module unit for receiving data to be stored, the transmitter module comprising means to selectively transmit at least some of the data received thereby; and

a pocketable data recorder for receiving data broadcast by the transmitter unit, and comprising data storage means for storing data received from the transmitter.

2. A data recording system as claimed in claim 1 in which the transmitter module is arranged to broadcast data continuously, and in which the recorder is arranged to continuously store the data received from the transmitter, whereby the recorder is arranged to record in a rolling update manner such that older samples of data are continually over-written by later samples.

3. A data recording system as claimed in any preceding claim in which the data storage means comprises means to permanently store at least some samples of data such that they cannot be over-written by later data.

4. A data recording system as claimed in any preceding claim in which the transmitter module comprises a further data store for storing samples of received data, in which the data selectively transmitted comprises at least some of the data stored in the further data store, transmission of data being initiated in response to a control signal.

5. A data recording system as claimed in claim 4 in which transmission of data to be stored comprises at least one burst of data at a relatively high rate such that the data becomes stored in the data storage means in a much shorter time than the time taken to store the corresponding data in the further data store.

6. A data recording system as claimed in any preceding claim in which the data storage means comprises a first portion and a second portion, the second portion comprising a non-volatile memory, the first portion being capable of being written to at a higher rate than the second portion, in which data received from the transmitter is initially written into the first portion and is subsequently transferred from the first portion to the second portion.

7. A data recording system as claimed in any preceding claim in which data is conveyed between the transmitter and the recorder by radio.

8. A data recording system as claimed in any one of claims 1 to 6 in which data is conveyed between the transmitter and the recorder via an inductive loop.

9. A data recording system as claimed in any preceding claim for use in an aircraft, comprising a further data recorder disposed in the body of the aircraft and arranged to receive and store data from the transmitter module, the further data recorder being arranged to be ejected from the aircraft in response to an emergency situation.

10. A pocketable data recorder for use with a system as claimed in any preceding claim.

11. A transmitter module for use with a system as claimed in any one of claims 1 to 7.

12. A pocketable data recorder substantially as described with reference to the drawings.

13. A data recording system substantially as described with reference to the drawings.

14. A data recording system substantially as described with reference to any one of the Figures 1-4 of the drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

-15-

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Relevant Technical Fields

(i) UK Cl (Ed.M) G1N (NAHJA, NAHJD); G4H (HRCS, HRCU)

(ii) Int Cl (Ed.5) G08C 17/00

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASE: WPI

Search Examiner
M G CLARKE

Date of completion of Search
13 MAY 1994

Documents considered relevant following a search in respect of Claims :-
1 TO 14

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2194370 A	(GEBR. EICKHOFF etc) whole document	10
X	GB 2128004 A	(NEC CORPN) see especially page 1 lines 9-29	10
X,P	US 5227766	(ass. to OKI ELECTRIC INDUSTRY CO) whole document	1,7,10,11

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